

CLAIMS

[Claim 1]

A pupil detection device comprising:

an image data extraction unit for determining a plurality of circles on an eye image as integrating circles respectively, and extracting an image data of the eye image positioned on the circumferences of the integrating circles;

a contour integrating unit integrating the image data extracted by the image data extraction unit along the respective circumferences of the integrating circles;

a pupil radius detection unit for detecting that an integrated value obtained by the contour integrating unit has changed stepwise with respect to the radius of the integrating circle;

a pupil position detection unit for detecting that the center coordinates of the integrating circle as pupil position coordinates when the pupil radius detection unit detects the stepwise change,

wherein the plurality of circles are set concentrically, and the image data extraction unit extracts the plurality of image data simultaneously.

[Claim 2]

The pupil detection device of Claim 1, wherein when a difference value between the integrated value of the two integrating circles having the closest radius out of the

plurality of concentric integrating circles is larger than a predetermined threshold, the pupil radius detection unit considers that the integrated value has changed stepwise with respect to the radius of the integrating circle.

[Claim 3]

The pupil detection device of Claim 2, wherein the predetermined threshold is set to a range between $1/4$ to $1/1$ times the difference between the integrated value when the integrating circle is located on an iris and the integrated value when the integrating circle is located on a pupil.

[Claim 4]

The pupil detection device of Claim 1, wherein the image data extraction unit comprises:

- a partial frame memory,

- the partial frame memory comprising:

- a plurality of line memories of first-in first-out (FIFO) type being connected, and

- drawing lines for drawing image data corresponding to pixels on the respective circumferences of the plurality of concentric integrating circles.

[Claim 5]

The pupil detection device of Claim 4 comprising a pointer unit for indicating center coordinates of the integrating circle,

- the pointer unit comprising a counter for counting a clock

synchronized with a period for acquiring the image data on the partial frame memory.

[Claim 6]

The pupil detection device of Claim 1, wherein the contour integrating unit comprises a plurality of adders for adding the image data extracted by the image data extraction unit along the respective circumferences of the integrating circles.

[Claim 7]

The pupil detection device of Claim 2, wherein the pupil radius detection unit comprises:

a subtracter for calculating a difference value between the integrated values of the two integrating circles having the closest radius out of the plurality of concentric integrating circles:

a comparator for comparing the difference value outputted from the subtracter and the predetermined threshold.; and

a register for holding the radius of the integrating circle in the case in which the difference value is larger than the predetermined threshold as a radius of pupil.

[Claim 8]

The pupil detection device of Claim 5, wherein the pupil position detection unit comprising a register, the register being configured in such a manner that when the pupil radius detection unit detects the radius of the integrating circle as the radius of the pupil, the counter output from the pointer

unit which points the center coordinates of the integrating circle in question is held as the pupil position coordinates.

[Claim 9]

An iris authentication apparatus comprising the pupil detection device of any one of Claim 1 to Claim 8.